Clinical and laboratory study of amputation surgery and rehabilitation

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Abstract:
The progress of a clinical and laboratory study of amputation surgery and rehabilitation is discussed.

Full Text:

PURPOSE--Prosthetics Research Study (PRS) continued ongoing programs of **clinical** and laboratory research into amputation surgery; immediate postsurgical amputee **management**; lower limb prosthetic development, including the automated fabrication of prostheses and other mobility aids; a basic and **clinical** study of **wound** healing as it related to amputation surgery and postsurgical **management**; engineering investigation into the mechanical properties of soft tissues and the response of living soft tissues to application of force; and technology transfer of automated fabrication **methods** into the **clinical** services of the VA medical care system.

PROGRESS--Preliminary design and engineering analyses of the prosthesis force transducer have been completed. The design incorporates piezoelectric quartz crystals as force-sensing elements to obtain force information at three discrete locations within the transducer. Given these data (9 forces), the complete set of forces and moments (Fx, Fy, Fz, Mx, My, Mz) at the socket due to ground reaction forces can be obtained. The device as designed will be less than 1 cm thick, 7 cm in diameter, and will weigh approximately 800 g. To date, the analog electronics have been purchased as well as the crystals and other raw materials.

In conjunction with the PRS diabetic footwear study, we have undertaken a study of three dimensional foot morphology. We have obtained digital images of over 100 feet using a Cyberware(TM) laser scanner, and over 50 pairs of images from an Amfit(TM) contact scanner. The laser-scanned images provide full 3-D shape information over the entire foot (dorsal and plantar aspects), while the contact scans provide only plantar surface information. Custom software has been written and the DVA/ShapeMaker(TM) software has been modified to facilitate quantitative comparison of these scans. To date only preliminary analysis of the data has been undertaken, but shows great promise as a tool for understanding foot morphology, as well as designing and fabricating custom insoles and footwear.

We have developed a compact, self-contained gait activity monitor (GAM) which records the number of steps taken by a patient over a 2-week period. The GAM does not require patient intervention and has a sealed, water-proof case which prevents tampering. It provides the clinician with an objective, reliable measure of functional outcome for evaluation of new prosthetic devices and medical treatments. We have built four prototype units and collected data

from three subjects for up to 1 week. We are currently refining the mechanical sensor and designing software for data analysis.

To study the response of skin to mechanical stress, we designed and built an automated mechanical stimulator capable of applying precise, repetitive forces in both the normal and shear directions. The stimulator was applied in vivo to the skin of pigs with gradually increasing amplitude over a specified number of days. At the end of the trial period, tissue samples were taken and studied using standard histological procedures. Preliminary experiments suggest there is a change in the structure of collagen fibers in response to the mechanical stress.

An optical silhouette scanner has been designed and constructed for measuring both diurnal and long-term volume changes in a residual limb. This device utilizes a rotating charge coupled device (CCD) camera and light source to obtain a series of 2-D silhouettes around the residual limb. The silhouettes are then reconstructed into a 3-D computer image of the residual limb from which volume measurements can be made. The device is currently under preliminary testing.

Studies were completed where it was found that gamma irradiation of blood transfusions inhibited their ability to sensitize to minor (non-major histocompatibility) transplantation antigens as part of a project to modify blood so as to prevent sensitization yet maintain the ability to induce tolerance for foreign transplant antigens.

The Automated Fabrication of Mobility Aids (AFMA) system makes it possible to produce a limb at reduced price in a shortened time. Rectification techniques permit a consistent socket fit. The data are easily filed with reproducibility of the limb and any needed adjustments easily, quickly, and inexpensively made. These techniques now include a PRS AK socket design unique in its characteristics in that it incorporates the advantages of both the classical quadrilateral socket, the narrow ML(Long) socket, and the advantages of a flexible/external frame socket. This technique together with the development of the VA/DAV/PRS Knee has allowed us to complete the lower limb prosthetic system as planned.

Training courses were developed and begun for the technology transfer of AFMA into the VA Medical Centers. Three centers were established on the west coast, two remote sites where AFMA limbs are now designed and fit and one central fabrication site where they fabricate the AFMA sockets. See also J Rehabil Res Dev 1994:31(4).

RECENT PUBLICATIONS RESULTING FROM THIS RESEARCH

Automated fabrication of mobility aids (AFMA): below-knee CASD/CAM testing and evaluation program results. Houston VL, Burgess EM, Childress DS, et al. J Rehabil Res Dev 1992:29(4):78-124.

Effect of FK506 and donor specific transfusion (DST) on skin and composite tissue allograft (CTA) survival in the rat. Kuroki H, Bean MA, Ikuta Y, Burgess EM. In: Transactions of the 38th Annual Meeting of the Orthopaedic Research Society, 1992, Washington DC, 1992:17(1):176.

Interface shear stresses during ambulation with a below-knee prosthetic limb. Sanders JE, Daly CH, Burgess EM. J Rehabil Res Dev 1992:29(4):1-8.

Partial calcanectomy for the treatment of large ulcerations of the heel, and calcaneal osteomyelitis: an amputation of the back of the foot. Smith DG, Stuck RM, Ketner L, Sage RM, Pinzur MS. J Bone Joint Surg 1992:74A(4):571-6.

Special considerations: fitting and training the bilateral lower limb amputee. Smith DG, Burgess EM, Zettl JH. In: Bowker JH, Michael JW, eds. Atlas of limb prosthetics: Surgical, prosthetic and rehabilitation principles. 2nd ed. St. Louis, MO: Mosby Yearbook, 1992:599-622.

All-terrain foot. Mathews D, Burgess E, Boone D. J Prosthet Orthot 1993:5(1):29-44.

Clinical measurement of normal and shear stresses on a trans-tibial stump: characteristics of wave-form shapes during walking. Sanders JE, Daly CH, Burgess EM. Prosthet Orthot Int 1993:17(1):38-48.

Effect of KF 506 and donor-specific blood transfusion on the rat composite tissue limb allograft and the mechanism of long-term graft survival. Kuroki H, Bean MA, Ikuta Y, Akiyama M, Burgess EM. Transplant Proc 1993:25(1):658-61.

Physical fitness: a guide for individuals with lower limb loss. Burgess EM, Rappoport A. Baltimore, MD:

Rehabilitation Research and Development Service, Department of Veterans Affairs, 1993.